A UNIQUE DOCUMENT OF ARCHITECTURE AND NEW BRONZE CASTING INSTALLATIONS ON THE SANCTUARY OF ZEUS AT GERASA (JARASH, JORDAN)

Jacques Seigne

Abstract

An exceptional architectural block was discovered at the northern entrance of the sanctuary of Zeus at Gerasa (Jarash). Identified as a pending keystone, it testifies to a unique and early technique. The decorated block, which was inscribed with an epigram, fits perfectly into the data concerning Diodoros of Gerasa, known as the architect of the vaulted corridors and propylon of the lower courtyard of the Zeus Olympian sanctuary in the first quarter of the Ist century AD. The donor, a certain Demetrius (named by inscription), might be the Gerasa citizen referred to in another inscription from the sanctuary, dated 9/10 AD, where he is mentioned as a former priest of Augustus.

Excavation under the collapsed stone vault blocks also uncovered new important remains of the 2nd century AD bronze workshop installation found and partially excavated in 1992 and 2012, which was covered by Byzantine and Roman period deposits. They attest that this artisanal bronze casting installation is the largest, and best preserved, which has so far been discovered from the Roman period.

Keywords - Gerasa, architecture, keystone, Greek epigraphy, bronze workshop, Roman period.

Reminder: The Vaults in the Sanctuary of Zeus

The sanctuary of Zeus at Jarash, ancient Gerasa, consists of two major parts, built into a hillside:

- A great peripteral octostyle temple on a high podium, built in 162/163 AD at the top of the hill overlooking the Oval Piazza,
- A large terrace (100 m x 50 m), constructed mid-slope. This terrace, known as the "Lower Courtyard", corresponds with the primitive nucleus of the sanctuary, established around the 'high place' and the cave where the remains of the first cult, dated to the middle of the 2nd millennium BC, were found. Over the following millennia, the sanctuary was progressively embellished[1]. At the beginning of the 1st century AD the Lower Courtyard was extended to the dimensions we know today. This courtyard was not surrounded by porticoes (as were most other regional Roman sanctuaries), but by a continuous stone barrel vaulted corridor on all four sides. A succession of small arched passageways allowed access from the open-air court to the shaded corridor. Three monumental entrances, in the middle of the south, north and east facades, gave access to the sacred area. For each of them, two exterior monumental doors (2.70 m wide), opened in the peribolos wall; inside were two corresponding, but double sized (5.05 m) doors overlooking the courtyard. Again, stone barrel vaults covered the passages to the exterior doors and inner bays. Cross vaults marked the penetration of these secondary structures, which, although of different widths and shapes, all had an intrados at the same level as the great barrel corridor vault. The complexity of these intersections made the stereotomy and cutting of the intersection blocks before construction extremely difficult[2]. The problem was solved in a very ingenious way, with no supporting scaffolding

1. For a general description of the sanctuary and its development phases, see Seigne *et al.* 1986: 31-42; Seigne 1993; Seigne 1997.

2. The technical problems raised by stone vault intersections are well known. The difficulties were such that the architects of antiquity avoided them. In this regard, see, for example, Adam 2011: 205-210.

(cintres) at the level of the intersections. Thus, the stones could be placed in simple chained stacks, leaving each one protruding inside the corridor at the level of the intersections. Arch-stone waiting beds were carved *in situ*, to support each block of the perpendicular vaulting. Once construction was completed, the cutting of the projecting tails for the arch-pieces allowed perfect edges, with a surprising final stereotomy of the intersection stones. In the absence of hanger support, the stability of the structures during the construction phase was obtained by wedging the corner blocks. The name of the architect of this remarkable achievement, dated 27/28 AD, is known by the inscription of the cruciform key stone from the southern entrance: Diodoros, son of Zebedos, of Gerasa[3].

Excavation of the Northern Entrance

Excavations carried out in the sanctuary of Zeus at Jarash (Jordan) between October 18 and November 27, 2014[4], were supported by an exceptional grant from the French Senate[5], The two objectives of the 2014 campaign were to:

- Collect as much information as possbible regarding the northern entrance of the sanctuary, the only one of the three which had not been excavated, although the few observable surface indices indicated that it was very similar to the southern entrance, which had been cleared in 1984[6];
- Check for any additional remains of the unique industrial workshop of large bronzes which had been discovered in 1993 and 2012[7].

The excavated area matches Squares AW 104 and AW 105, as well as the southern half of Squares AX 104 and AX 105. Before the work had commenced, only two blocks were visible *in situ* on the surface; both were at the west jamb of the outer door. At the rear, in the collapsed vaulted corridor, a wide depression over a meter deep was probably a former test trench opened by H. Kalayan in 1981. A lot of detritus from previous Jarash Festivals had accumulated there. Its removal allowed us to observe that the 1980 sounding had reached, at ± 9.20 m, the level of the collapsed vaults. In undisturbed areas, the search revealed that more than 1.20 m of sandy soil covered the collapsed fragments (level ground before work to ± 10.65 m). The origin of this grey-black sand deposit, which was subsequent to the ruin of the building, is not exactly known, but that it is the result of a long and continuous process (wind?) is clear. Fleeting remains of occupation (s?) were found during clearance; ceramic finds assign a date from the 11th -12th centuries of our era.

A compact layer of collapsed stone vault blocks, mixed with yellowish clay (waterproof coating of the roof?), 0.70-1.50 m thick, was uncovered throughout Squares AW 104 and 105. Removal of the large number of soft limestone vault blocks[8], most unfortunately in a very bad state of conservation, required many days of work, thankfully somewhat reduced with the assistance of the DoA crane.

A – The Keystone Block

During the clearance, found exactly in the center of the passage, and covered by fallen arch-stones, was an unusual, hard white limestone block. Placed vertically, 28 cm wide and 80 cm long, it was pierced by a horizontal hole, which was clearly intended for the passage of a lifting cable. Its sides have relatively symmetrical carved areas. Removal of the

3. Seigne 1985 (*SEG* 35, 1569); Seigne 2008.

4. The mission was composed of Anne-Marie Jouquand, archeologist at Inrap, Anne-Michèle Rasson-Seigne, archaeologist ceramologist, Giancarlo Filantropi, topographer, Frédéric Thomas, archaeologist, and Jacques Seigne, Director. Ali Al-Owaisi and Mohammad Atoom were the Department of Antiquities (DoA) Reprasentatives, with Ahmed Shami, the DoA Inspector of Antiquities for Jarash. We also thank Dr. Munther Dahash Jamhawi, Director General of the DoA, for the permanent support and courtesy he has kindly given to the publication of this article. The study will also be published in *Syria*, in French.

5. Our sincere thanks go to Mrs Christiane Kammermann, Senator, for the financial support she gave to the Jarash mission. Without her grant, the 2014 excavation campaign could not have taken place. The mission also received financial subsidies from the Commission des Fouilles of the French Ministry of Foreign Affairs.

6. Seigne 1985.

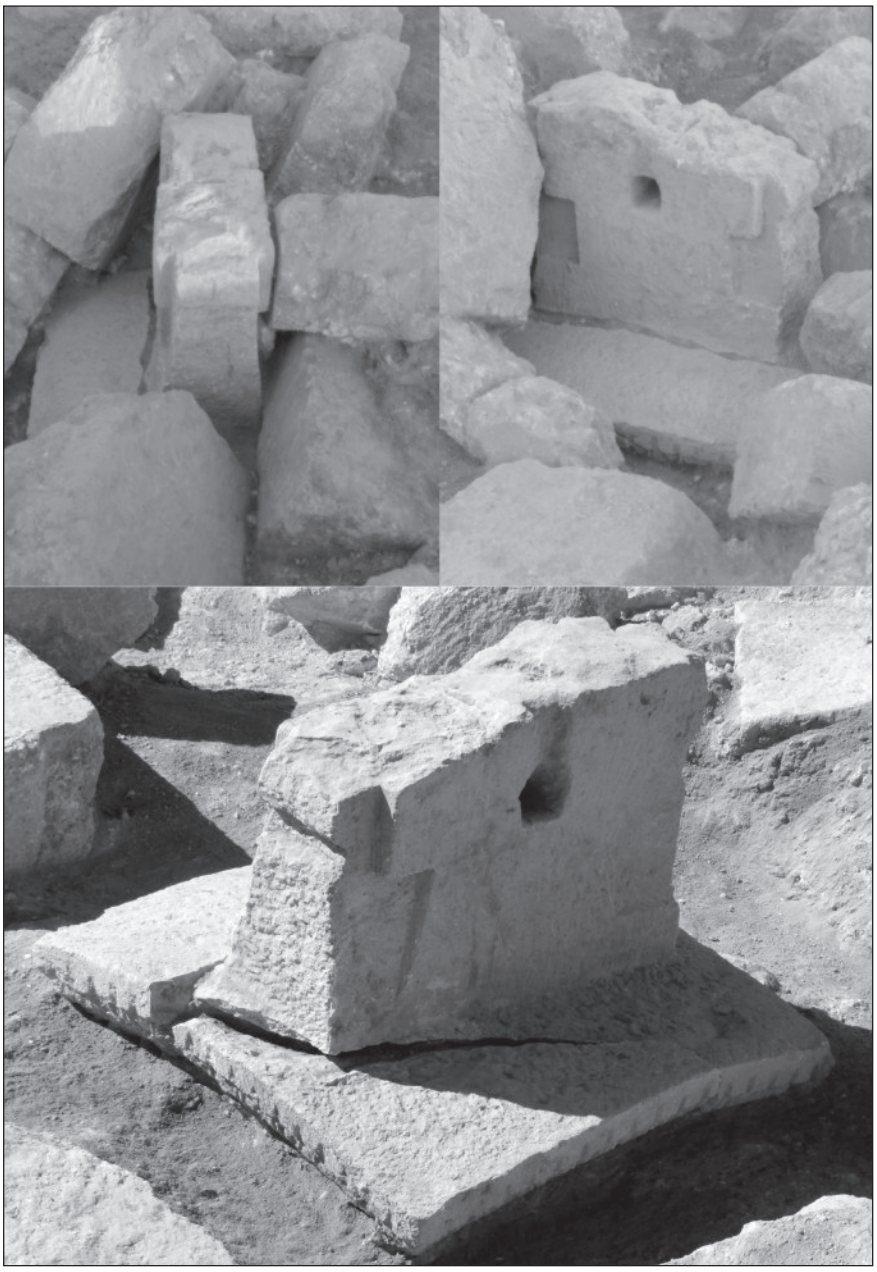
7. Khalil, Seigne and Weber 2013.

8. Hard limestone (*melekiyeh*) was only used for the frames of the three doors built through the peribolos wall (with red limestone used for the main east entrance, and white for the north and south gates). The rest of the construction was exclusively constructed from soft limestone (*narry*).

arch-stones which surrounded it allowed us to determine that it measured more than 60 cm in height, and widened abruptly at its base (under the collapsed vault stones which covered it), to form a slightly concave slab 96 cm wide and 30 cm thick.

Initially placed at the intersection of the four vaults which covered the passages from the northern entrance, this block was both engaged in the mass of the arch-stones and partially covered by them, as its fallen position shown unequivocally (**Fig. 1**). There is no doubt about its function; it is the keystone of the whole. Of an estimated 800 kg weight, it represents both décor and exceptional form (**Fig. 2**). Its general shape is that of a huge square nail with a head close to a meter on each side, associated with a rectangular tail, 60 cm long. Size and sculpture of such an element are, in themselves, a real "tour de force". It was certainly the work of a master stonecutter.

Removal of the block allowed us to see that its underside was decorated and inscribed. A row of "oves" (eggs), surmounted by a row of dentils, adorns the outskirts of the square, while a stylized small palm marks each corner.



1. The suspended keystone at the north entrance, in situ at the time of the discovery.

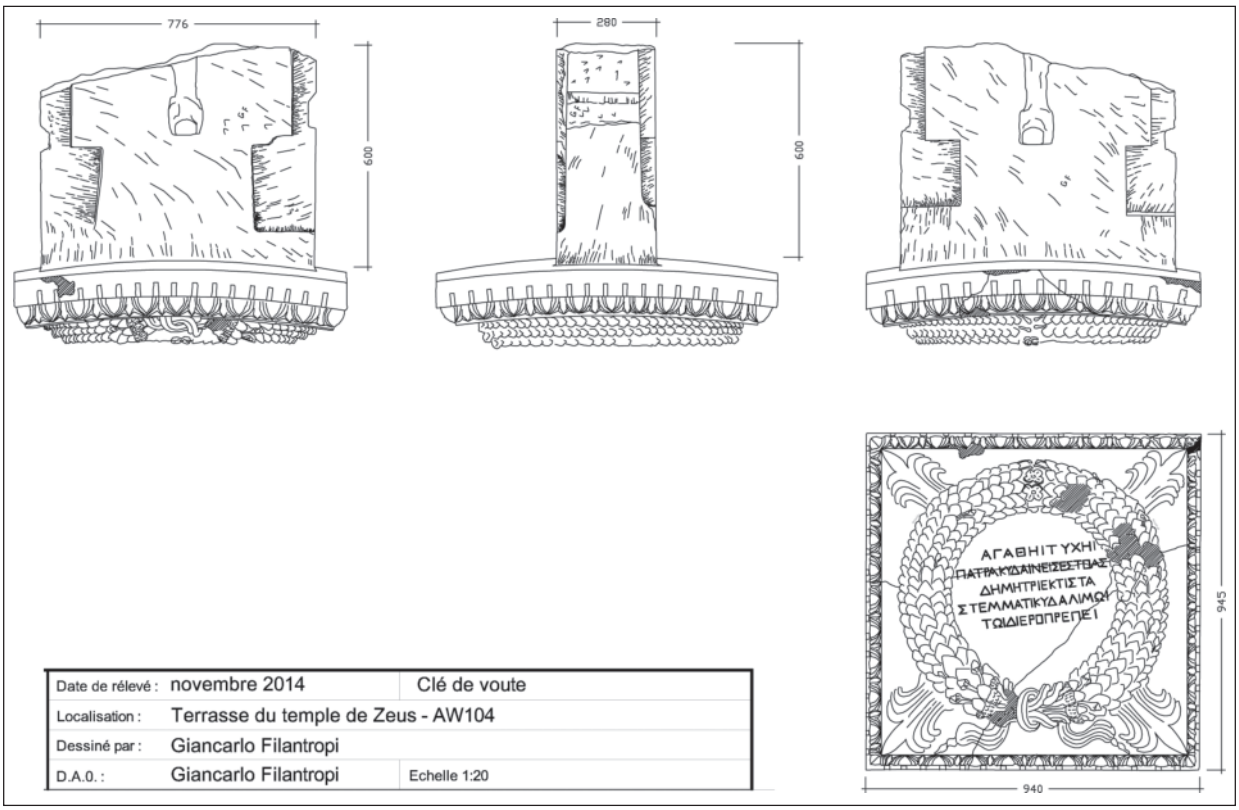
A thick crown in strong relief, composed of nested leaves, dotted with acorns[9] and four petal flowers, occupies the field, surrounding a five line Greek inscription. The latter, arranged according to the axis of the corridor, faced eastward; hence was not directly readable by a person entering the sanctuary by the north entrance. This particular disposition, apparently provided for people circulating in the northern corridor, could perhaps correspond to an error in design or realization, or that the axis of the housing for the tail of the block had shifted 90 during construction. However, such an error appears very strange in such a well-constructed building, and for an inscription of this importance. Maybe should we see it as the will to make it readable by any visitor coming from the East, from the main entrance to the sanctuary.

Greek Inscription

The block of limestone, which is complete but broken into four fragments, is decorated on the under face with a crown of oak leaves in high relief as described above. The inscription, an epigram of five lines, occupies the center of the crown (**Fig. 3**). It honors a certain Demetrius, who may be the citizen from Gerasa referred to in another inscription from the sanctuary, dated 9/10 A.D (Gatier 2002: 277-278). It fits perfectly into the information relating to Diodoros of Gerasa, known as the architect of the vaulted corridors and the propylon of the lower court of the Zeus Olympian area in the first quarter of the 1st century AD. The inscription will be published by Mr Pierre-Louis Gatier.

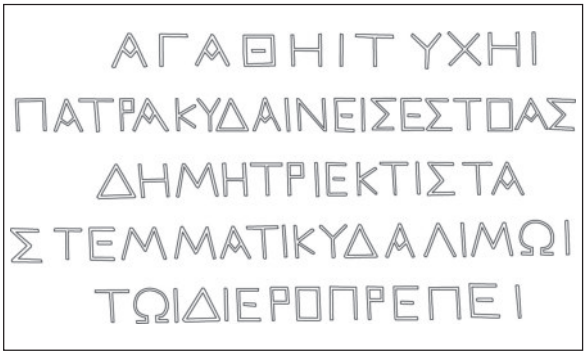
The Function of the Block

The major interest in the block is neither its decor nor the inscription it bears (although these are both exceptional), but its shape and, hence, the function it fulfills. The huge rectangular section lug (0.28 m x 0.60 m x 0.78 m) visible opposite the decorated surface is slightly pyramidal in shape, and was originally placed inside and at the top of the vaults, thus occupying the central intersecting point. It corresponds to the real key of the vaulted ensemble. The block



2. The suspended keystone at the northern entrance (Drawing and Computer Graphics: Giancarlo Filantropi 2014).

9. We know the symbolic link between Zeus and oak.



3. The inscription from the suspended keystone.

would not have been of significance if it had not been placed by the vaults intrados, by the bottom surface, and not by the extrados, because of the large, salient, decorated medallion adorns its lower bed. The presence of this medallion, which would have covered the arch-stones on the intrados level that surrounded it, as well as the inverted pyramid shaped lug, confirm that the block was lifted, not lowered, into place.

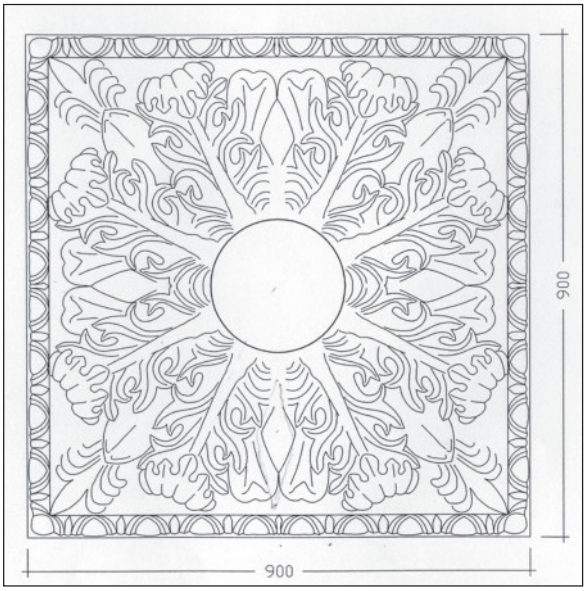
It would have been impossible to place the blocks using wooden scaffolding (cintre). The discovery of this new type of key vault stone confirms previous discussions regarding construction of the different stone vaults of the sanctuary, in particular in terms of the level of their intersections; their construction was partially carried out without hanger support (see above). The development of this unique technique, apparently known only at Jarash, no doubt helped Diodoros, the brilliant Gerasasian architect, to demonstrate that a keystone was not necessarily required, but that crossing vaults, or a cupola, could even accept a vacuum at their summit. Of polygonal or circular plan, such an opening could be scheduled, or left open[10] (or closed) by a keystone. Perhaps this is what prompted Diodoros to take full advantage of the opportunity to test the implementation of a revolutionary key vault by suspending a large, decorated medallion from the underside of the arch-stones.

If lifting an 800 kg block, as well as placing it into a recess in the vault was not a problem (using a cable through the hole prepared in the block tail for this purpose), attaching it to the vaulted structure was probably less easy. Unlike a normal key block, it was not self-locking, but had to be attached to the neighboring stones using pins, wedges or other devices. No metal (iron or copper alloy) was found during the search, which means these pins, wedges, and other fixing elements were therefore probably made from perishable materials (wood?), but also perhaps from lime mortar. It is indeed remarkable that the only witnesses of mortar joints uncovered during the excavation were found around this block during the clearing of the collapsed vaults. The different traces and holes noted on the vertical sides of the block tail probably played an essential role for anchoring it. We must imagine it was kept in place by hammering various materials (such as wood, mortar, small stones, etc.) into the small spaces, so as to hang this pendant key from the support vaults. Even though we do not know exactly what was used, it is clear that the anchoring material filled its role; the key only fell as a result of the widespread collapse of the vaults, probably during the earthquake of 749 AD, as the stratigraphic study reveals. It is certain that this carved block, apparently stuck on the underside of the vaults and defying gravity, did not fail to impress visitors, while recalling the tribute to the generous sponsor by his city.

To our knowledge, this carved and inscribed stone is the oldest physical attestation of a suspended keystone in architecture.

This discovery also allows interpretation of two fragments of reddish hard limestone block which were found more than twenty years ago near the eastern entrance to the sanctuary, and whose function heretofore remained unexplained. It is, on one hand, a block corner, decorated with a stylized small palm, and on the other hand, a fragment from a rectangular concave slab associated with a broad leaf acanthus in high-relief. This slab fragment, as the block found in the northern entrance, has the beginnings of a wide rectangular tail at the back of the decorated face. The two fragments found twenty years ago can now be attributed to the pending keystone adorning the main entrance of the sanctuary to the east (**Fig. 4**). Their more sumptuous décor, carved in a rare, hard, red limestone block, is different from that of the pending keystone of the northern access,

10. As the oculus he sought, at the top of the dome on columns built at the same time at the propylaeum of the sanctuary (see below).



4. Graphic restitution of the keystone's decorated face at the eastern entrance (Drawing and computer graphics: Giancarlo Filantropi 2014).

which is not surprising at the main entrance of the sanctuary. The circular recess in the center of the block probably held a bronze inscribed plate(?), which unfortunately has not been preserved.

Finally, these elements allow the uppermost part of the stone cupola, supported by columns, which stood on the propylaeum over the east access to the sanctuary to be accurately described and drawn; three rows of arch-stones, decorated with strong projecting large acanthus leaves, were placed in a vertical position. These segments formed a wreath of leaves pointing downwards, of increasing sizes from an uppermost oculus, taking the decorative principle of the suspended keystone from the main entrance to a monumental scale. There again, the adopted architectural solution (oculus and arch-stones in a vertical position), as well as the decoration, is unique and has no other parallel in ancient architecture, nor the dome on columns with which they were associated. All these structures confirm the exceptional inventiveness and the technical mastery of Diodoros, son of Zebedos, the architect of Gerasa.

Dating

The inscription is not directly dated. However, several convergent clues allow a probable chronology.

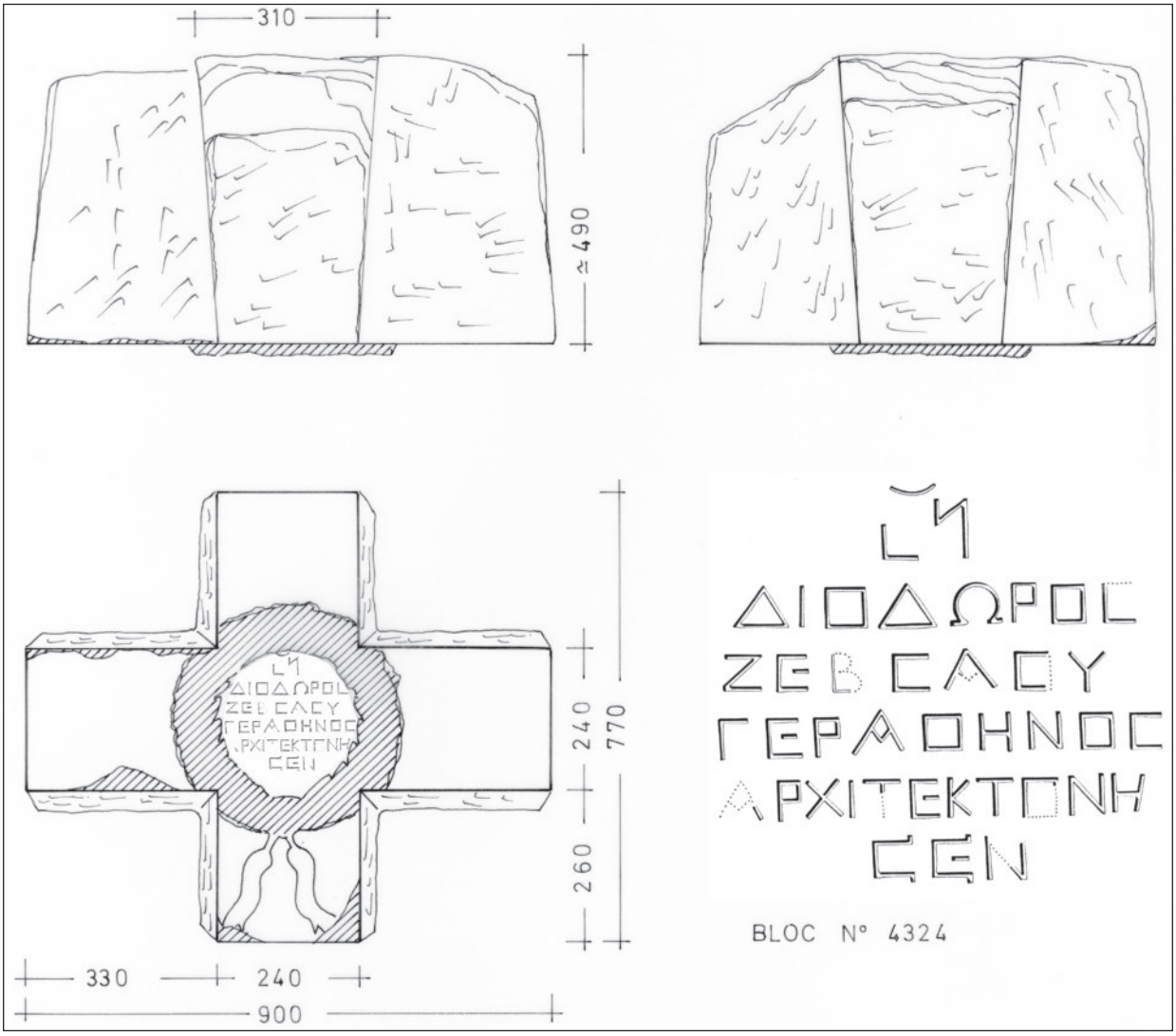
- Palaeography is typical of 1st century AD engravings[11].
- The white hard limestone used, until now, is known only on the most ancient of the monuments at the site. At the end of the 1st century AD, or at the latest from the beginning of the 2nd, it was replaced by pink hard limestone, from, in particular, the quarries of Dayr al-Liyat[12].
- The quality of the sculpture offers supplementary information. The work and carving of the "oves", as well as the crown and stylized small palms, without using a drill, is characteristic of the first half of the 1st century AD in Jarash, if not the end of the 1st century BC[13].
- The nature of the block, a keystone from the vaulted corridor surrounding the lower court of the sanctuary, provides the most accurate dating, as we know from earlier discoveries that all corridors structures were, in all likelihood, completed in 27/28 AD[14].

This discovery means that all three keystones which once adorned the vaulted entries to the sanctuary are now known; that for the North entrance, the object of this study, that of the main gate to the east, which is fragmentary and undated, and the one for the south entrance, with an inscription indicating the work had been done by Diodoros, son of Zebedos, of Gerasa, in 27/28 of our era (**Fig. 5**). However, although two of these key vaults are of the unique suspended type, the third one, which mentions Diodoros, is of a more classical shape, and installed by the vaults extrados. It could therefore be assumed that the latter one, which is more normal, and less revolutionary, despite its cruciform shape, would have been in place before the other two, and hence likely to be earlier.

But this is probably not the case; it is more likely that the two other keys were built first. Several arguments may be presented as evidence:

- We know, without doubt, that the main

11. See above.
12. Seigne 2000.
13. Architectural sculpture from the 1st century BC in hard limestone is, for the moment, very poorly represented on the site.
14. See Seigne 1985.



5. The keystone at the southern entrance (Drawing: Jacques Seigne 1985).

entrance to the sanctuary was in the east, where a monumental and exceptional propylon, with a stone dome resting on columns, was built in front of the oriental gate. Similarly, it is possible to assert that the northern entrance, on the street from the Oval Plaza to the South Theatre, was more important than the southern one, opening directly outside of the city. It is therefore very likely that the southern access was the least important of the three;

- In other monumental constructions of antiquity, most effort related, in general, to the main entrances, in the most visible facades, on the busiest gates[15]. It is therefore very likely that the east and north , as well as their vaults and suspended associated keystones, were constructed prior to the south entrance;
- Similarly, it is unlikely that an inscription mentioning an architect, even one as brilliant as Diodoros of Gerasa, could have been engraved before those celebrating a generous donor, who was a former priest of the imperial cult or of Olympian Zeus, as well as a member of one of the most powerful families of the city;
- Finally, the realization of the hanging keystones, in hard limestone, represents a technical "tour de force". Only exceptional stonecutters were able to carve such blocks without them breaking, and the cost of

15. Examples abound, including the west portico of the sanctuary of Bel at Palmyra, the facade of the sanctuary of Artemis in Jarash, etc.

completion had to be important. The return to a more traditional and cheaper solution (keystone in soft limestone, standard stone of the vaulted corridors, easier to carve and set up, classically, by the extrados face), seems more understandable for the realization of the south entrance keystone, as completion of the work on the sanctuary appears to have been marked by significant financial difficulties[16].

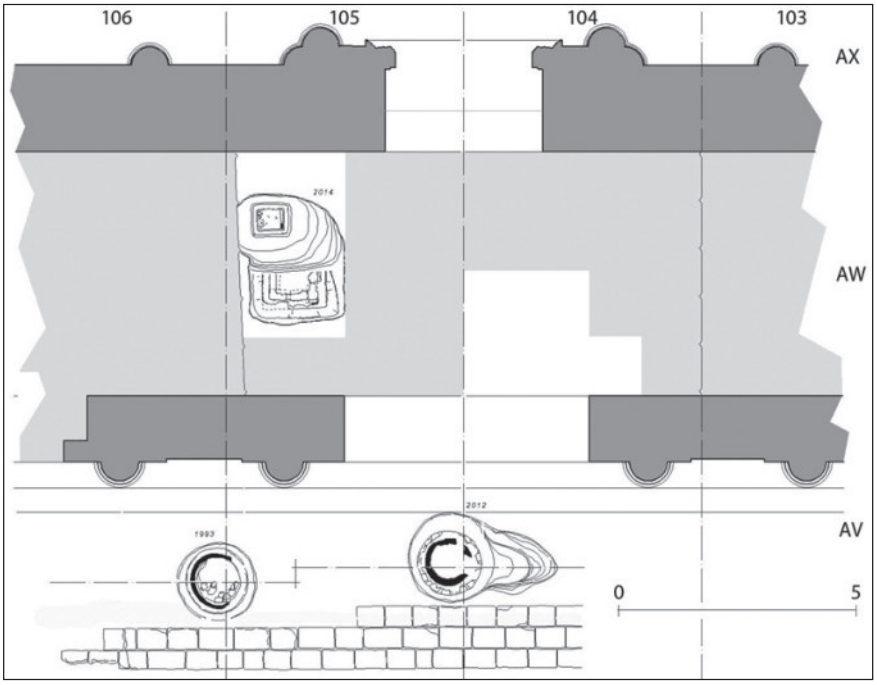
Thus, everything leads us to believe that the timeline for constructing the keystone vaults was as follows; east entrance, then north passage and finally south passage. If the inscription which honored Demetrios should be prior to that of Diodoros, (as stated above) then the inscription which mentions Diodoros should be later, at the end of the first quarter of the first century of our era.

The new block discovered in the sanctuary of Zeus at Gerasa is a testiment to a peculiar period of history of the city; the beginning of the Imperial era. By itself and the inscription contained therein, it documents the local architecture, politics and cultural traditions of this period. It illustrates the activity of two men, the notable evergete (benefactor), Demetrios, and, especially, the brilliant local architect Diodoros, son of Zebedos, author of surprising technical innovations. Each in their own way, they contributed to the realization of a large monument, the sanctuary of Zeus Olympios, which also housed, from the beginning of the 1st century AD, the cult of the emperors.

B – The Remains of a Large Bronze Workshop at the Sanctuary, an Unexpected Discovery

The scientific purpose of the French mission, which had been excavating and restoring the sanctuary of Zeus and its surroundings at Jarash since October 1982, was to study and attempt to understand the major organization and evolution phases of an oriental urban sanctuary from Hellenistic and Roman times.

In 1993, in the northernmost part of the Lower Terrace Courtyard, between the *naos* and the northern part of the peripheral stone vaulted gallery, the discovery of the remains of a bronze workshop was a great surprise: nothing foreshadowed the presence of such an artisanal installation within the sacred area, particularly in a level from the end of the 2nd century AD. In an unpaved part of the courtyard, a large (1.65 m) and deep (1.40 m) pit housed, still in situ, the basis of a large circular mold, probably that of a large basin. Thousands of fragments of molds, nozzles and chunks of burned clay, as well as a great deal of bronze slag, all evidence of a copper alloy workshop, were found in the



6. The bronze workshop: excavated molds in situ (Drawing and Computer Graphics: Giancarlo Filantropi, Jacques Seigne 2014).

16. See Seigne 1985.

filling of the pit.

The discovery seemed important, not only because of its nature, a workshop for «large bronze» objects, but also for its location, inside the sanctuary, and the considerable number of mold fragments discovered, some of them having probably served in the manufacture of drapery for large statues. However, it did not comply with the objectives of the mission, and none of the team members were familiar with ancient metallurgy. Furthermore, at that time, it was not possible to find a French specialist for Roman statuary who was interested in studying these remains. Gabriel Humbert, the ceramologist for the mission, completed the first cleaning, classification and restoration work on the discovered pieces, then all of the fragments were put in boxes and stored, waiting for specialist attention.

In the spring of 2012, thanks to Dr. Rafe Harahsheh, the newly appointed DoA Inspector of Antiquities for Jarash, all the fragments of marble statues which had been discovered during the previous forty years of excavation, from various locations on the site, were, for the first time, collected and stored in a single room at the archaeological camp. Dr. Thomas Weber, a Roman statuary specialist representing DAAD in Jordan, was available to study them[17] During one of his site visits, the conversation turned to non-marble sculptures, and focused on the ancient bronze workshop pit in the sanctuary of Zeus. As soon as he had examined the boxes of mold fragments, Dr. Weber immediately set to work. Thanks to him and his contacts, he immediately associated the project with the Johannes Gutenberg University and the Roman-Germanisches Zentralmuseum in Mainz, and a project study, which included restoration of the molds, was launched[18]. The partners for the project were the Universities of Mainz, Jordan and Yarmouk, the DoA, and the French archaeological mission. Support from these institutions, together with the embassies of the Federal Republic of Germany and France[19], allowed, in the summer/autumn 2012, the complete restoration of several molds[20], after recording[21] and photographing[22] of the fragments, together with ceramological and metallographic analyses[23], had been completed. During the autumn, after studying the results of the first restoration and analyses, research in the northern part of the sanctuary[24], postponed since 1993, could commence again; most of the finance was provided by a special grant from Germany. By chance, another casting pit, similar in all respects to that uncovered in 1992, was discovered only five meters to the east, in the same stratigraphic level (dated to the second half of the 2nd century AD). It housed, again still in situ, the remains of a large circular mold base (more than one meter in diameter), similar to the first one. Only the filling from the pit differed; instead of mold fragments, it contained many fragments from firing ovens (crucibles, walls, nozzles, etc,) which complemented the previous documentation and information on the foundry, together with furthering knowledge of ancient bronze manufacturing techniques. The presence of restoration specialists from Mainz[25], together

17. For many years, management of the Jarash Archaeological Park had been complicated by internal rivalry from local representatives of the DoA. One of the most important consequences was the absence of any overall organization for the collection of information, or even finds, especially statuary. Many discoveries (ceramic, coins, bronze, etc., as well as marble statues and inscribed and/or decorated architectural blocks) were not recorded. They were stored, when they were, in deplorable conditions and often left behind on the ground, outdoors, in various places. Any attempt to collect and update information was refused by some local officials. In 2013, after the departure of some of these officials, Dr Rafe Harahsheh organized a systematic collection of marble fragments in a suitable storeroom for the first time.

18. Jordanian-European Cultural Heritage Conservation Program at Jarash, funded by the Hashemite Kingdom of Jordan, the Republic of France and the Federal Republic of Germany.

19. The project was, for the most part, sponsored by the Federal Republic of Germany. However, it also received support from Mr Aumis, the Cultural Attaché for the French Embassy in Amman, and Mr Marc Griesheimer, the Assistant Director for the French Institute of the Near East (IFPO).

20. By Nina Heyer and Lotte Maue, conservators.

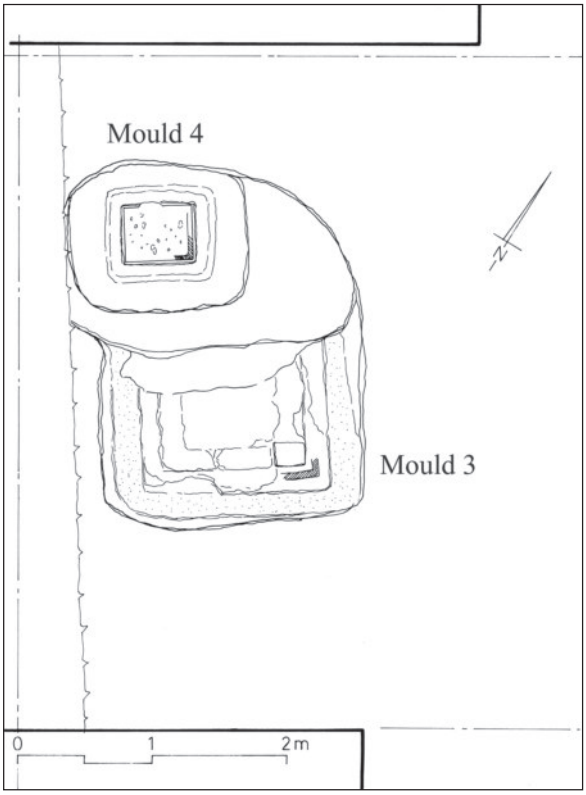
21. By Khairiyeh al-Kuhkun and Abd el-Nasr Hindawi from the University of Jordan.

22. By Mohammad Adi, photographer from the University of Jordan.

23. By Mustaffah Naddaf, from the University of Yarmouk and Lutfi Khalil from the University of Jordan.

24. By Anne-Michèle Rasson-Seigne and Christina Wolf.

25. All members of the archaeological team participated in the removal of the mold, with restoration under the direction of Christian Eckmann.



7. Bronze molds 3 and 4 in situ in the northern vaulted corridor (Drawing: Giancarlo Filantropi, Jacques Seigne 2014).

with administrative and technical support from the responsible Jordanian authorities[26], enabled the remains of the mold to be removed and transferred to the Jordan Museum for future restoration and exhibition, together with other pieces found during both excavations of the bronze workshop.

The discovery of this second casting pit, and the material it contained, confirmed the exceptional importance of the Jarash discovery, by increasing our knowledge of the ancient technology for manufacturing large bronzes[27]. It also verified that the search had so far only reached the outskirts of the bronze workshop. For technical reasons, such facilities are generally established under shelter, to protect the molds and ensure, as much as possible, constant light, in order to properly judge the temperature reached by the melting metal. Therefore, it appeared that the two pits established outside the gallery were most likely installed there due to lack of space elsewhere. They could then be interpreted as the remains of the last two major bronze casting areas used before the abandonment of the workshop. Moreover, the main area of activities should be sought nearby, within the northern vaulted corridor of the sanctuary.

In 2014, Madame Kamermann, a French Senator, provided a special grant which allowed us to explore the hypothesis. In October/November 2014, new research was undertaken at the northern entrance to the sanctuary. The excavation was considerably delayed by clearance, removal of blocks from collapsed vaults (see previous sections in this article)[28], and the study of important Umayyad and Byzantine remains in the underlying archaeological levels. Despite these constraints, and the fact that the 2nd century AD level could be reached in a small area only, the hypothesis was fully confirmed, as the entire space was occupied by the remains of two new casting pits. Shallower than those found in 1993 and 2012, they were used to manufacture rectangular and almost square large bronze objects, (0. 60m x 0.60 for the smaller, and 1.20 m x 1.10 for the larger). The filling of these pits contained a large number of firing oven fragments, nozzles, a few mold fragments, a great deal of bronze slag, some small lead ingots, and, for the first time, many molded plaster fragments (sculpture models?).

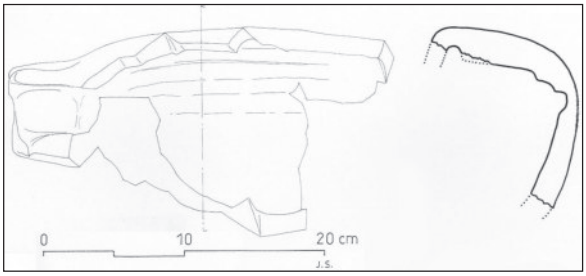
The Bronze Workshop

The 1993 and recent excavations proved that only a small part of the exceptional Jarash bronze melting installations have been excavated. It is also clear that the workshop for the production of large bronzes was probably first installed under the vaults of the Northern

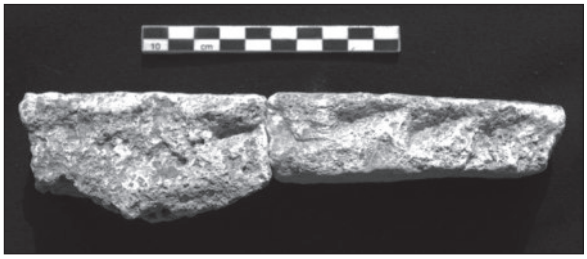
26. Our sincere thanks go to H.R.H. Princess Sumayya Bint Tallal and to his Excellency Mr Nayef al-Fayez, the Minister of Tourism and Antiquities, who agreed to and assisted as much as possible in the transfer.

27. The great earthquake of 653 was, most probably, the origin of the collapsed vaults in this sector. The excavation was delayed for a time, first because of the necessity to wait for the DoA crane to be available, but particularly by the unexpected discovery of a singular suspended keystone block, which was decorated and inscribed (P.-L. Gatier and J. Seigne 2015).

28. Preliminary results for the excavation and restoration of the bronze workshop were published early in 2013, thanks to funding from DAAD: (Lufti A. Khalil, Jacques Seigne and Thomas M. Weber, 2013).



8. Mold fragment (Drawing: Jacques Seigne 2014).



9. Fragment of molded plaster.

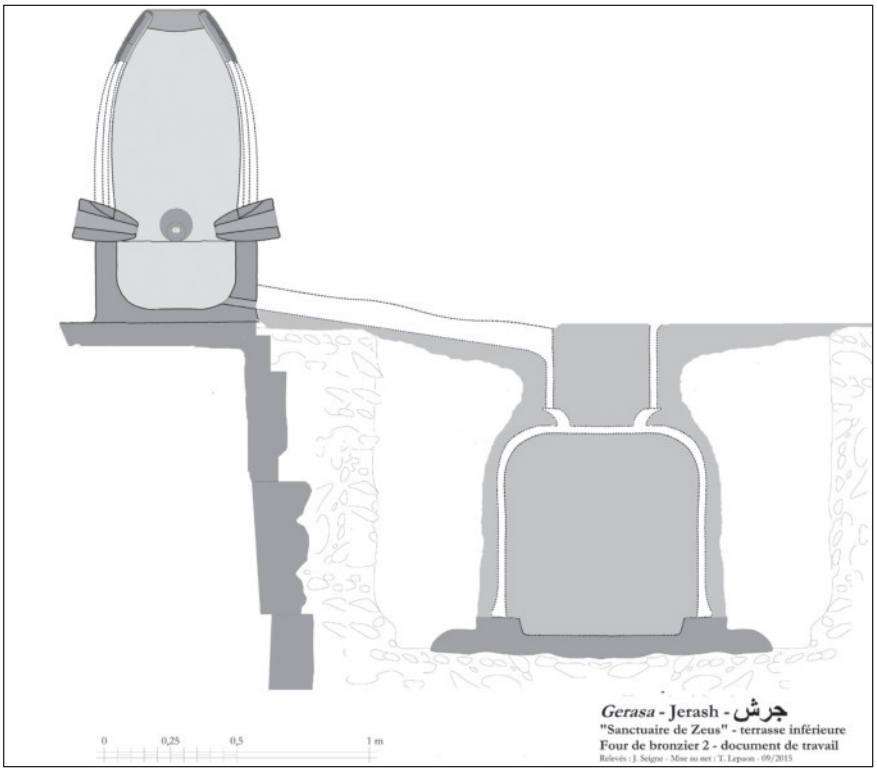
Corridor of the sanctuary. Apparently, so many pits had been dug and filled inside the corridor, the soil became so unstable it was no longer possible to dig new casting pits in that area, and the last(?) two (at least) had to be dug in the courtyard of the shrine.

The four excavated casting pits all have the same characteristics:

- They were dug in the early 1st century AD (inside corridor) and early 2nd century AD (courtyard) construction embankments of the sanctuary. Their shape and dimensions reflect the objects which were made, and only a narrow space (0.20 m to 0.30 m wide) between the mold and the sides of the pit allowed the founders to work on the construction of the outer mold;
- It is very likely that this narrow peripheral circulation was blocked (with sand?) after completion of the mold and before casting (strengthening resistance of the mold);
- No trace of calcination, or more generally of firing, was found on the walls of the pits;
- Similarly, the mold fragments remained in situ and appeared uncooked. Only the inside mold surfaces that have been in contact with molten metal show signs of "cooking".

In addition, the four pits remains excavated included:

- Objects that belonged to at least four kilns, in which between 200 and 400kg of metal were processed each time (estimated metal volume is calculated from the size of the melting chambers discovered);
- The remains verify that these kilns were built on the ground and not mobile;



10. Hypothetical reconstruction of the bronze melting installation. (Hyp.: Jacques Seigne, Computer graphics: Thomas Lepaon 2015).

- Therefore, the liquid bronze flowed by gravity between the kilns and the molds;

The different molds found in situ and in the fillings from each pit prove that this workshop was used to manufacture large basins and statues. The large number of "small" independent molds, for parts of larger statues (draperies), confirm previous studies of antique bronze statue techniques. These molds, some of which have been completely restored and are more than 0.50m in length, were cooked before melting (the "cire perdue", (lost wax) method).

What's more, such artisanal remains, in the sacred area inside a sanctuary, can be explained, in our opinion, only by the nature of the objects manufactured; that is, directly for the sanctuary.

All information which has been gathered as a result of the excavation and analyses for the bronze workshop confirm that it was, in all probability, functioning to provide equipment for, and decoration of, the large octostyle temple built in 162/163 AD.

Only a part of the casting installations have been excavated at this stage. We hope that, one day, someone will be able to complete the excavation and the study of this exceptional antique workshop.

J. Seigne, Tours (2015)

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